Trends in Lightning Electrical Energy Derived from the Lightning Imaging Sensor

Real time : 25 msec!

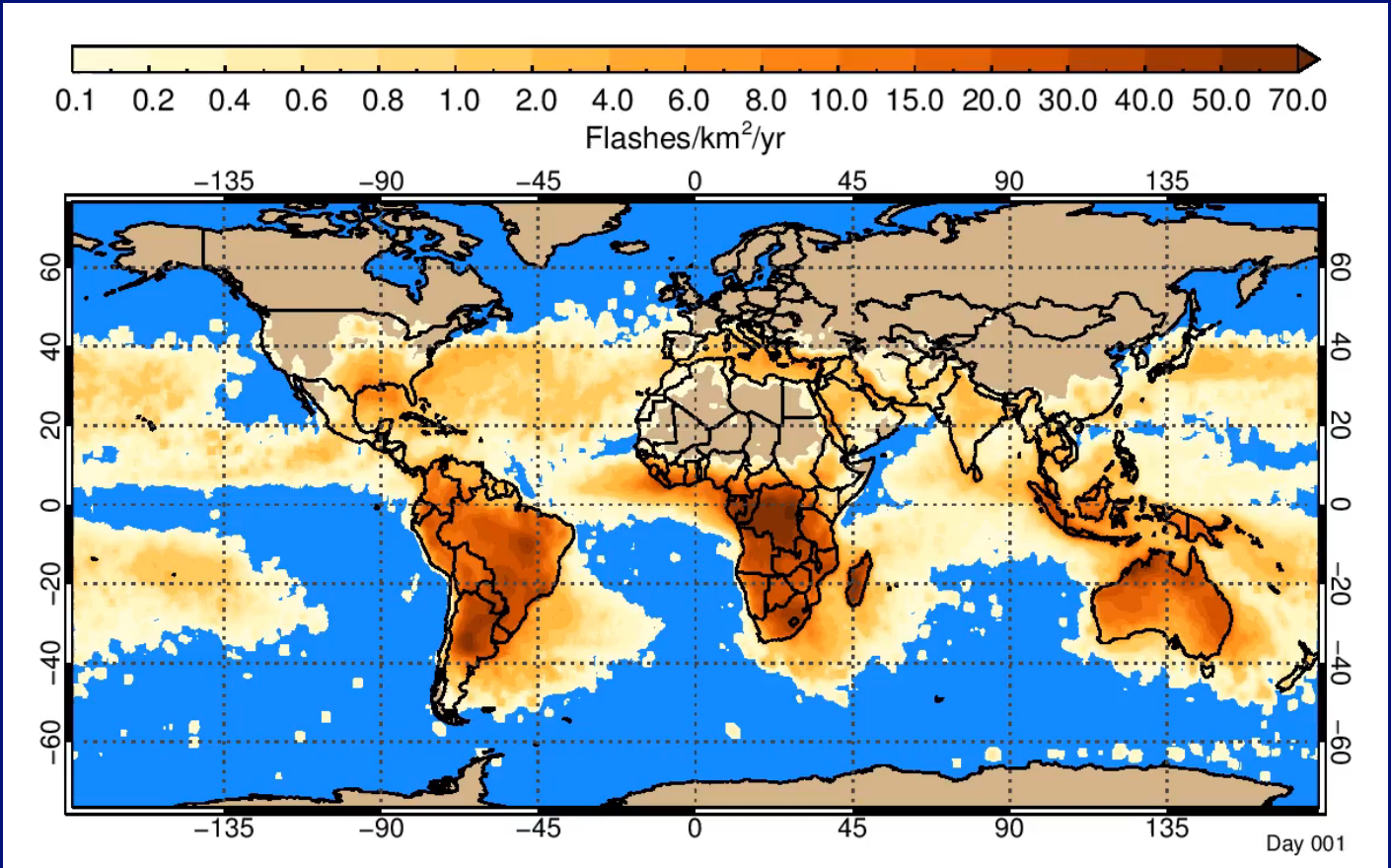
Phillip M. Bitzer and William J. Koshak

NASA

ATMOSPHERIC SCIENCE

Frame 00550

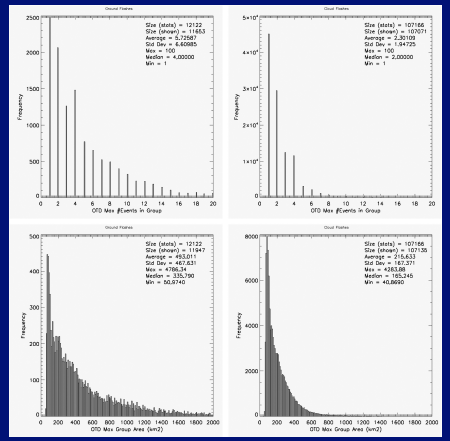
Traditionally, LIS has been used for flash counting



Recently, there has been an uptick in exploiting “lower level” attributes of LIS data

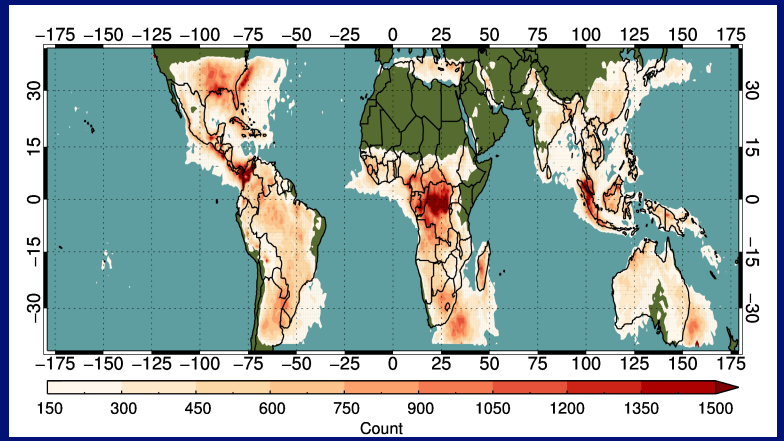
Bitzer et al. 2015, Bitzer 2016, Peterson et al. 2016, Koshak 2010, Koshak 2014

IC/CG



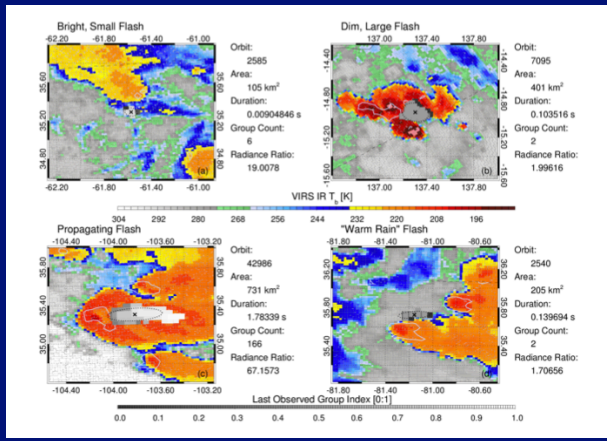
Koshak, 2010

Continuing Current



Bitzer, 2016

Propagating Flashes



Peterson et al., 2016

LIS also provides a measure of the energy for each lightning flash

via the spectral energy density (radiance)

$$E_k = \gamma_k Q_k$$

The energy of the kth flash/group is proportional to the “radiance”

$$Q_k = CA\Delta\lambda \sum_j \left[\frac{a_j \cos \alpha_j}{r_j^2} \right]_k \xi_{jk}$$

projected pixel footprint

distance to footprint

measured “radiance”

each depends on the lens boresight angle (Koshak et al. 2000)

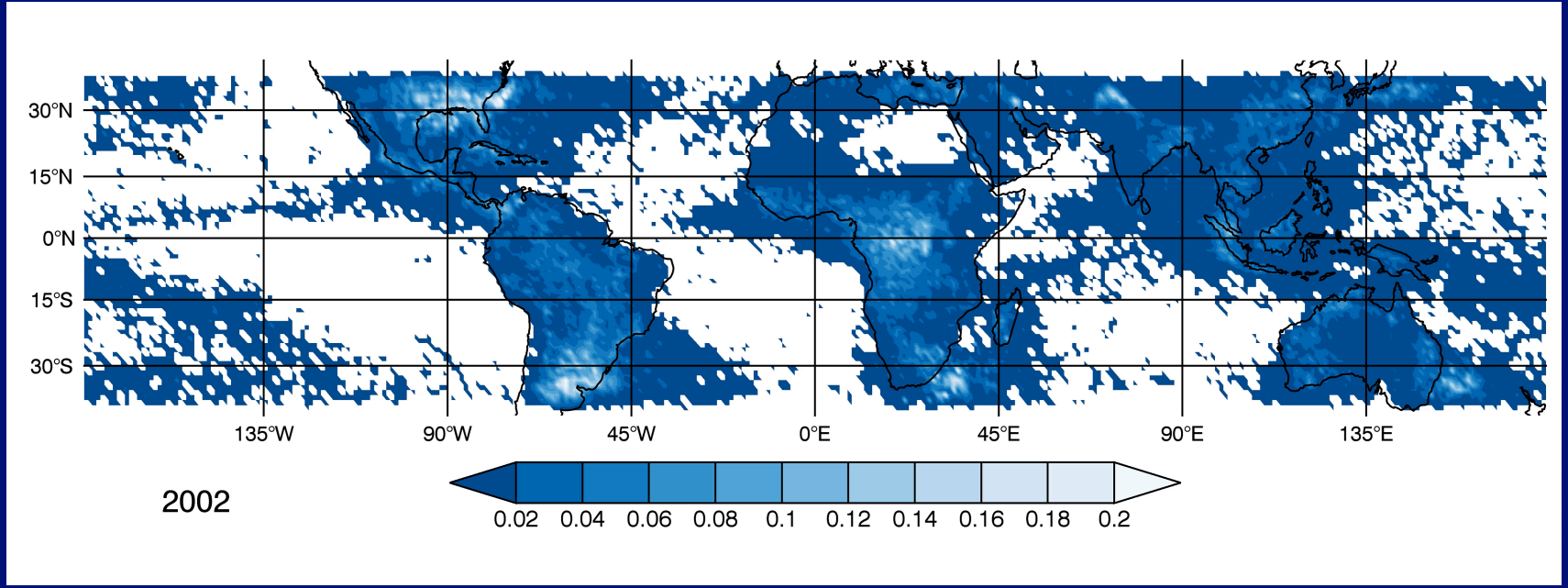
Caveats

Does not account for different cloud properties (averages out)

Does not account for varying cloud depths (averages out)

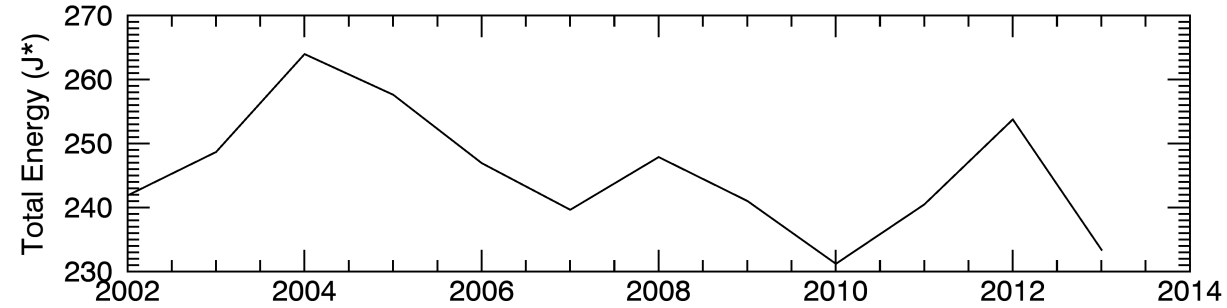
Assumes “radiance” measurement is stable (Buechler et al., 2014)

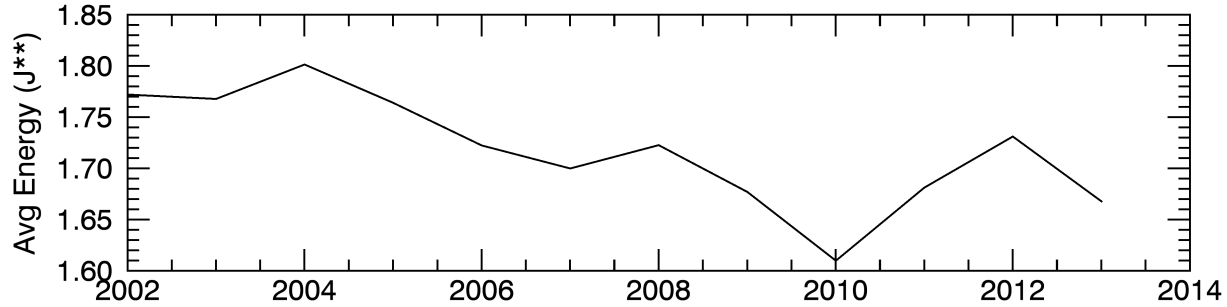
What is the spatial distribution of flash energy per year?



Total Flash Energy Per Year

Are there any time trends in the energy?

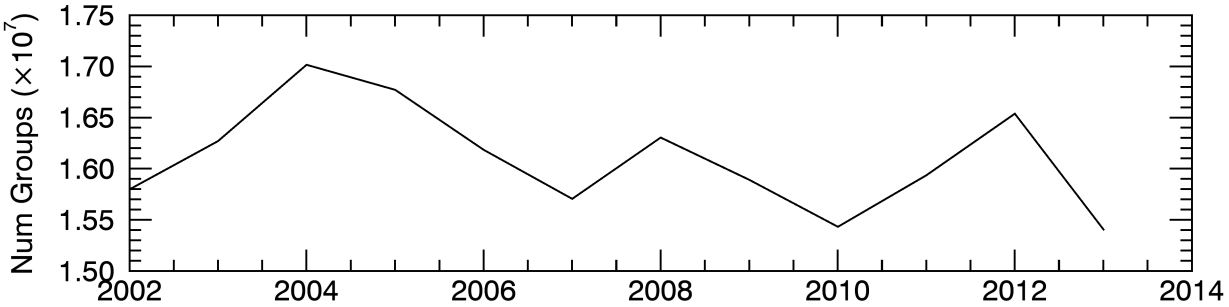


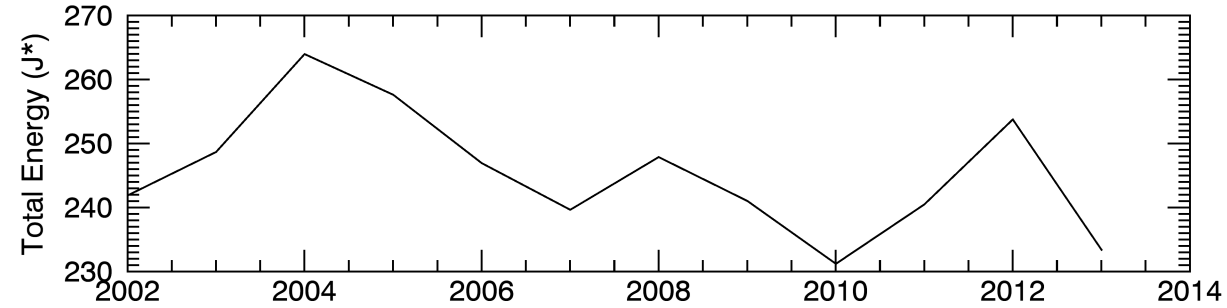


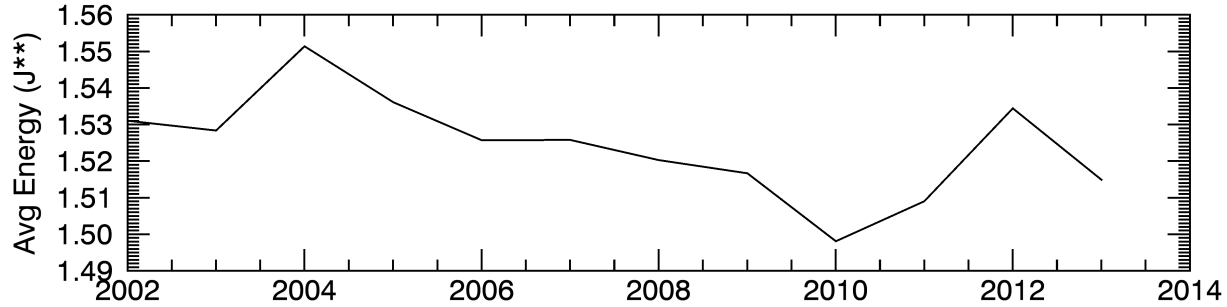
The number of flashes has been relatively constant

but the overall energy has decreased

and the average energy per flash has decreased



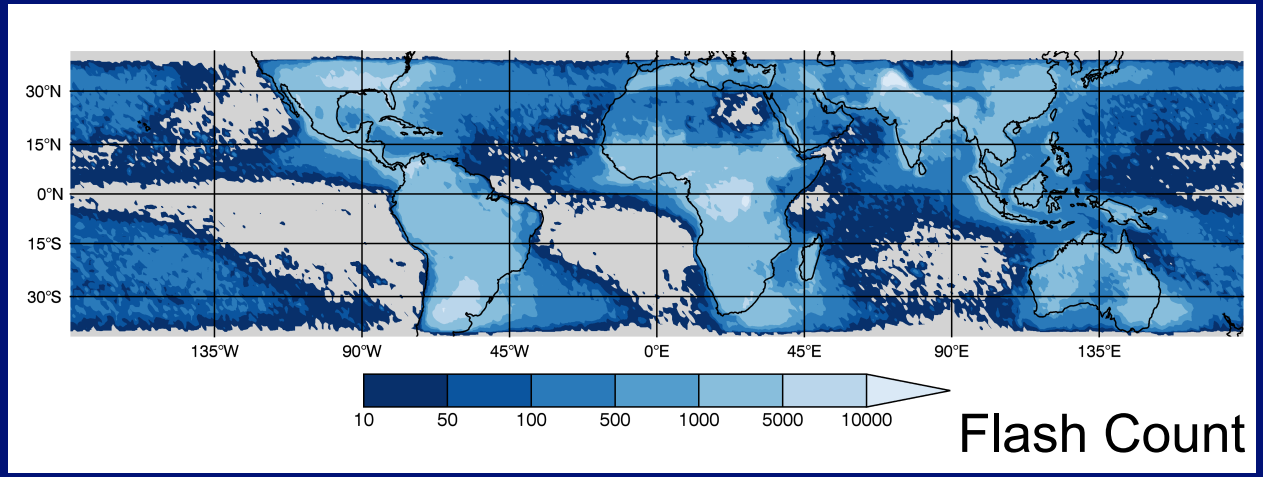




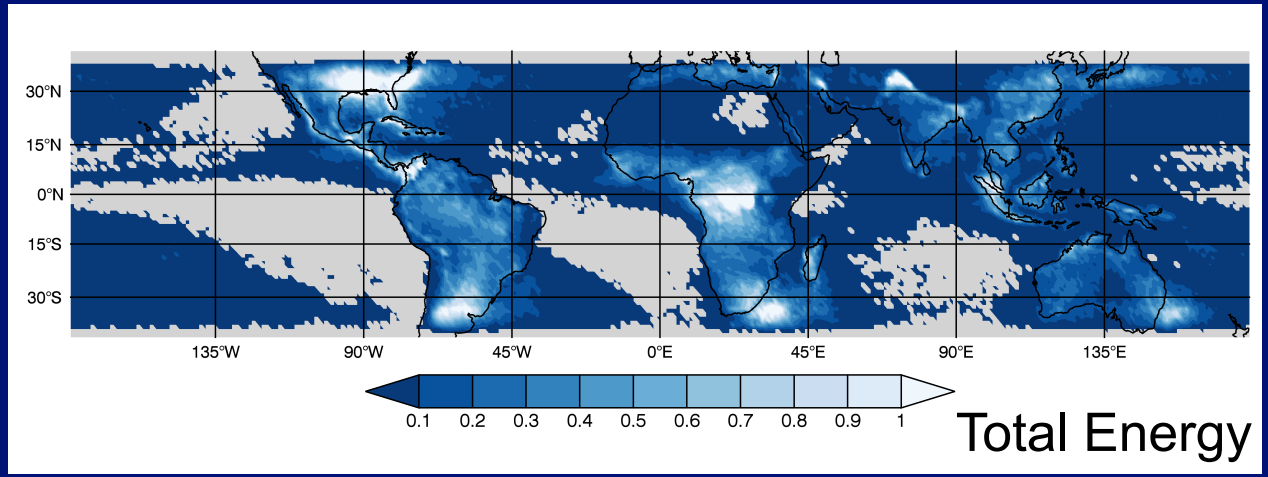
The number of groups has been relatively constant

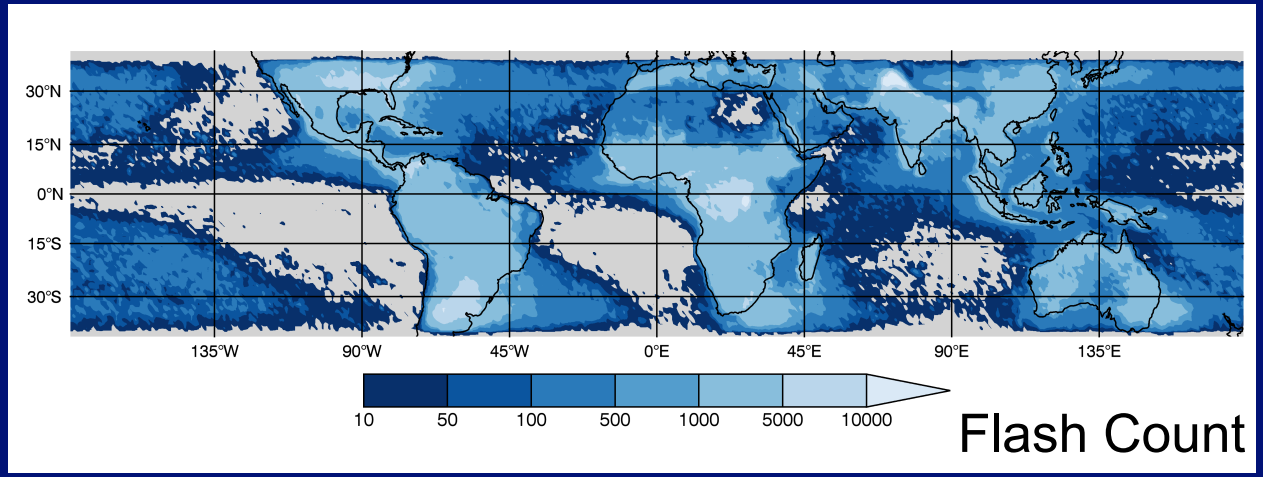
but the average energy per group is also relatively constant

What does the climatology tell us?

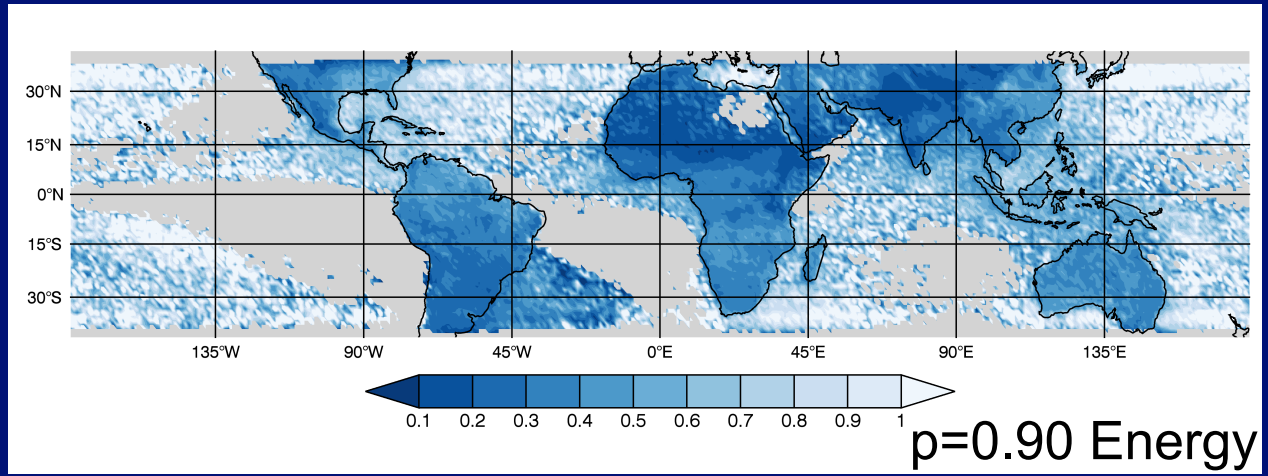


Unsurprisingly, the total energy mirrors the flash count

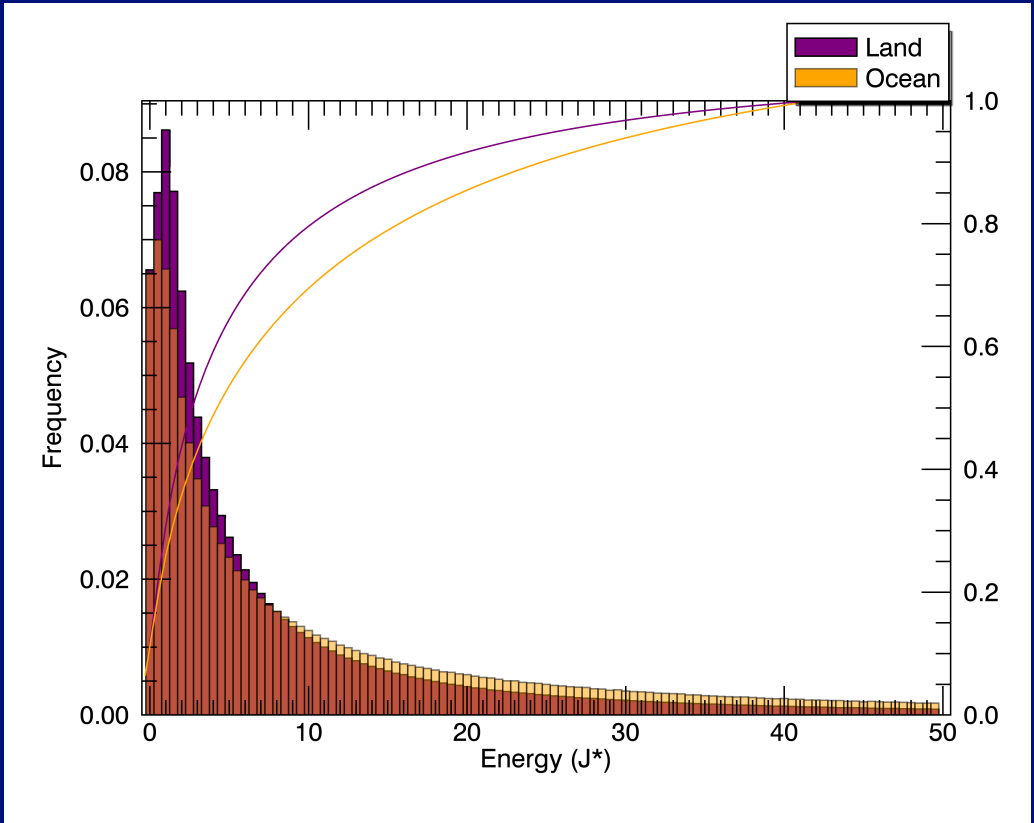




But, higher energy flashes occur over the oceans



*holds for smaller percentiles



By any reasonable statistical test (e.g., K-S), these distributions are significantly different

Are there any time trends in the energy?

The overall optical flash energy has decreased

The energy per flash has decreased, but the energy per group has remained constant

What does the climatology tell us?

Oceanic flashes, while less frequency, have higher optical energy per flash